

Preliminary

**dn'max variation over an entire orbit  
under SRCA 10W/ND and 1W lamp illumination  
(in comparison with predicted SRCA output change)**

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May 17, 2000**

- ◆ The SRCA provides tracking of dn' ( $DN - DN_{dark}$ ) change at different orbit positions.
- ◆ MODIS band dn' shows changes at different orbit positions mainly for bands 3 and 9. They could be the effect of earth shine.
- ◆ The model to predict SRCA band radiance change was proven prelaunch and works well on-orbit. The approach of dn' tracking over the orbit by using the SRCA is satisfied.
- ◆ The dn' change for band 7 under 10W lamp illumination needs further study.
- ◆ The overall report should be completed after all six tests covering constant radiance/current and 10W/10W\_ND/1W lamps.

## Description of the operations

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- ◆ The purpose of the test is to detect possible gain changes over an orbit for the Solar Reflective Bands (SRBs) (Bands 1 - 19 and 26).
- ◆ The SRCA was in radiometric mode.
- ◆ The lamp was in constant radiance mode.
- ◆ The lamp configuration was 10W lamp with Neutral Density filter in place or 1W lamp.
- ◆ The lamp was warmed up for three minutes until it was stabilized.
- ◆ The 10W/1W lamp was on over an entire orbit (about 100 minutes).
- ◆ Ten frames of detector dn's together with the SRCA engineering data form the data base for the analysis.

## Motivation of tracking the SRCA output band radiance change

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- ◆ Detector  $dn'$  could change over orbit.
- ◆ The SRCA as a light source to monitor MODIS change requires that the SRCA output band radiance is stable over the orbit.
- ◆ However, the SRCA output band radiance might change due to changes of lamp environment temperature and filament parameters although the SRCA broadband output remains constant in constant radiance mode.
- ◆ An approach to detect the SRCA output band radiance change has been developed.
- ◆ Ground test data show that the approach is proper.
- ◆ Subtraction of SRCA change from measured  $dn'$  change gives the  $dn'$  change of MODIS for the SRBs.

## Approach of tracking the SRCA output band radiance change

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- ◆ Lamp color temperature is mainly determined by lamp power.
- ◆ Due to the existence of the relationship between voltage and current, the relationship between lamp current and color temperature can be derived.
- ◆ The SRCA lamp manufacturer (Welch Allyn) suggests the following equation to relate lamp current to lamp filament color temperature

$$\frac{100 \cdot T_{\text{lamp}}}{T_{\text{Nominal}}} = 57.7 \cdot \ln\left[\frac{100 \cdot I_{\text{lamp}}}{I_{\text{Nominal}}}\right] - 165.66$$

- ◆ The SBRS recommended equation to relate the lamp color temperature to lamp resistance is not applied because the resistance is not directly measured.
- ◆ Ground test data show that the lamp radiance change can be well tracked by both lamp power and current in the SRCA constant radiance mode.
- ◆ A calculation model is established to calculate the SRCA output band radiance change when constant radiance mode is in action.

## Tracking the dn' and SRCA band radiance change

- ◆ Under the SRCA 10W/ND illumination, bands 13 - 16 are saturated; the short wavelength bands (1, 3, 4, 8 - 12) have too low signal under 1W illumination.
- ◆ The dn' change and the SRCA output band radiance change are expressed as the dn' ratioed by the value for the first scan.

$$dn'_{\text{change}}(\text{rotation}) = \frac{dn'(\text{rotation})}{dn'(1)} - 1;$$

$$dL_{\text{SRCA}}(\text{band}, \text{rotation}) = \frac{L_{\text{SRCA}}(\text{band}, \text{rotation})}{L_{\text{SRCA}}(\text{band}, 1)} - 1$$

- ◆ The SRCA band radiance change versus mirror rotation uses a fifth order polynomial for the trending line because the feedback control leads to high frequency lamp parameter variations in a preset range.
- ◆ If the dn' change and the SRCA band radiance change trending line is overlapped or parallel, that indicates the detector dn' has no change over the orbit. The dn' change is attributed to the SRCA output change itself.

**$dn'_{max}$  under SRCA 10W/ND & 1W lamp illumination**

Band	Current center wavelength mean value ( $\mu m$ )	$dn'_{max}$		dn' $_{max}$ variation: stdev/avg*100	
		10W/ND	1W	10W/ND	1W
8	0.412	57	--	1.0	--
9	0.442	151	--	0.4	--
3	0.466	49	--	1.6	--
10	0.487	368	--	0.4	--
11	0.530	705	--	0.4	--
12	0.547	1041	128	0.3	2.8
4	0.554	138	--	0.5	--
1	0.647	165	--	0.4	--
13	0.666	Saturated	778	Saturated	0.9
13hi	0.666	Saturated	1079	Saturated	1.2
14	0.677	Saturated	895	Saturated	1.0
14hi	0.677	Saturated	1258	Saturated	1.4
15	0.747	Saturated	1565	Saturated	1.8
2	0.860	731	229	0.1	0.3
16	0.866	Saturated	2688	Saturated	3.0
17	0.904	1185	406	0.1	0.5
18	0.936	905	327	0.1	0.4
19	0.936	1221	441	0.1	0.5
5	1.242	2188	1150	0.2	1.4
26	1.375	2564	1448	0.2	1.7
6	1.630	2198	1411	0.2	1.7
7	2.115	1996	1403	0.3	1.6

## **dn'<sub>max</sub> and the SRCA lamp variation**

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- ◆ The SRCA 10W lamp has better feedback control with variation of 0.3% while 1W lamp has a feedback control up to 1%. That explains why the dn'<sub>max</sub> variation in the previous sheet (stdev/avg.\*100) is higher for the 1W lamp than that for 10W/ND.
- ◆ Bands 3 and 8 have a dn'<sub>max</sub> less than 60 which results in a high dn'<sub>max</sub> variation.
- ◆ 1W lamp has minimum temperature variation according to the ground test data. It can be reasonably assumed that the SRCA has no change for bands 13 - 16. We can attribute the changes to MODIS if any. However, the SRCA 10W lamp output radiance variation over an orbit has to be tracked.

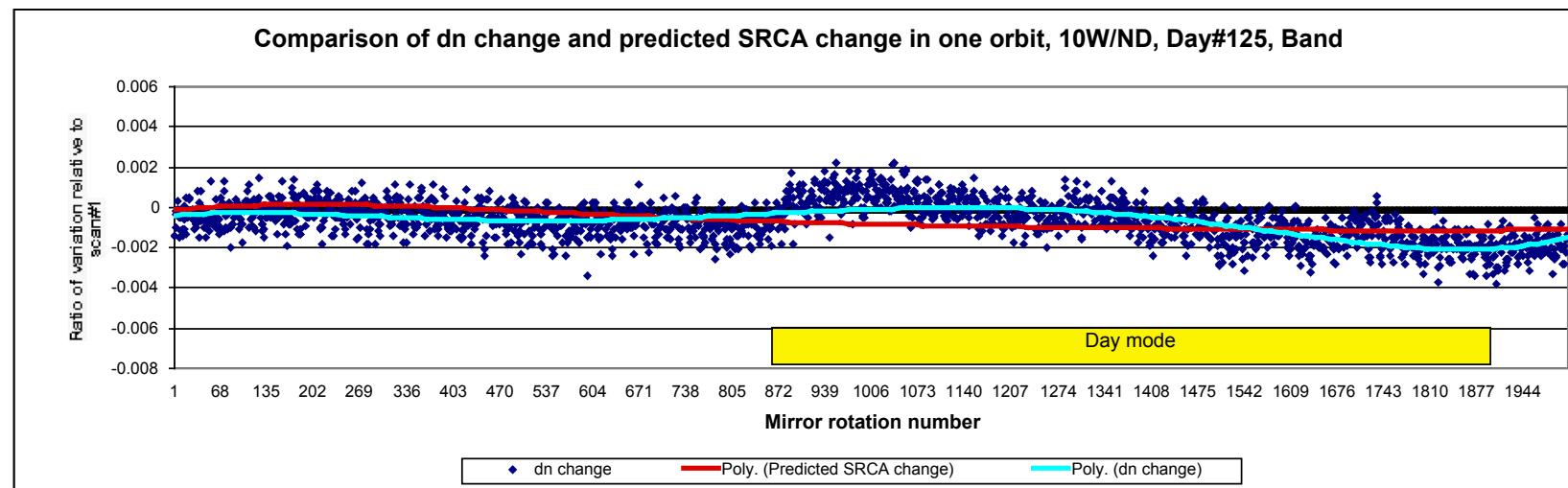
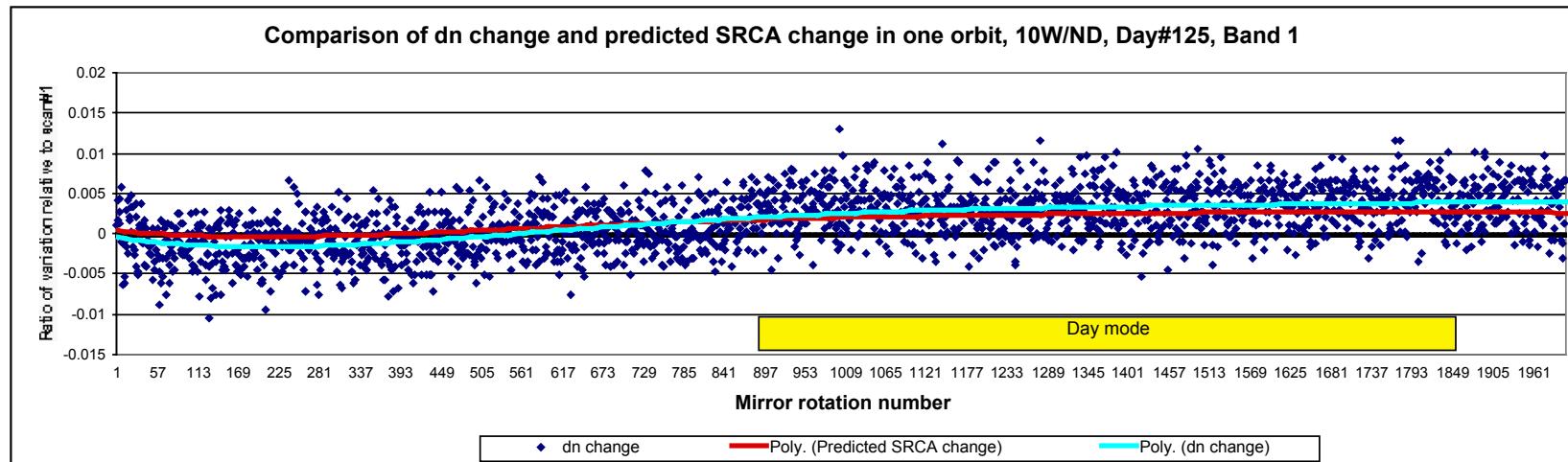
## Summary of detector dn' change under 10W/ND lamp

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- ◆ The following charts are for bands 1 - 12, 17 - 19, and 26.
- ◆ We observed that an evident change of dn' at mirror rotation of 870 (scan number of 1740) for band 2, 3, and 9 under 10W lamp illumination. We find that was the time when MODIS switched from night mode into day mode. The dn' change might be caused by the earth shine. The dn' change is 1.5 for bands 2, 3; and -1.5 for band 9.
- ◆ dn' has minimum change for bands 1, 4, 5, 6, 8, 11, 17 - 19, and 26. The dn' variation is due to the change of the SRCA output radiance.
- ◆ dn' trending lines are illustrated. The dn' and SRCA radiance change trending curves match very well for bands 1, 4, 8, 10 - 12, 17 - 19.
- ◆ dn' change for band 7 is beyond our prediction. According to the SRCA lamp output profile the dn' change should have the same tendency for bands 5 - 7 and 26. However, it shows an increasing over test time which contradicts the SRCA output decreasing over time (proved by bands 5, 6, and 26).

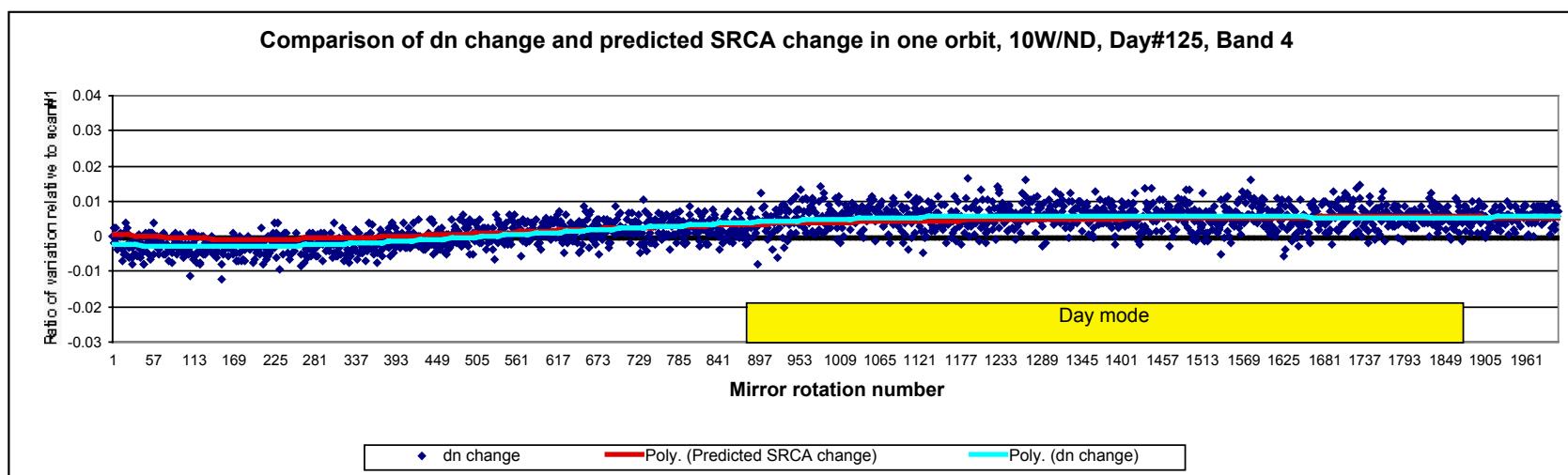
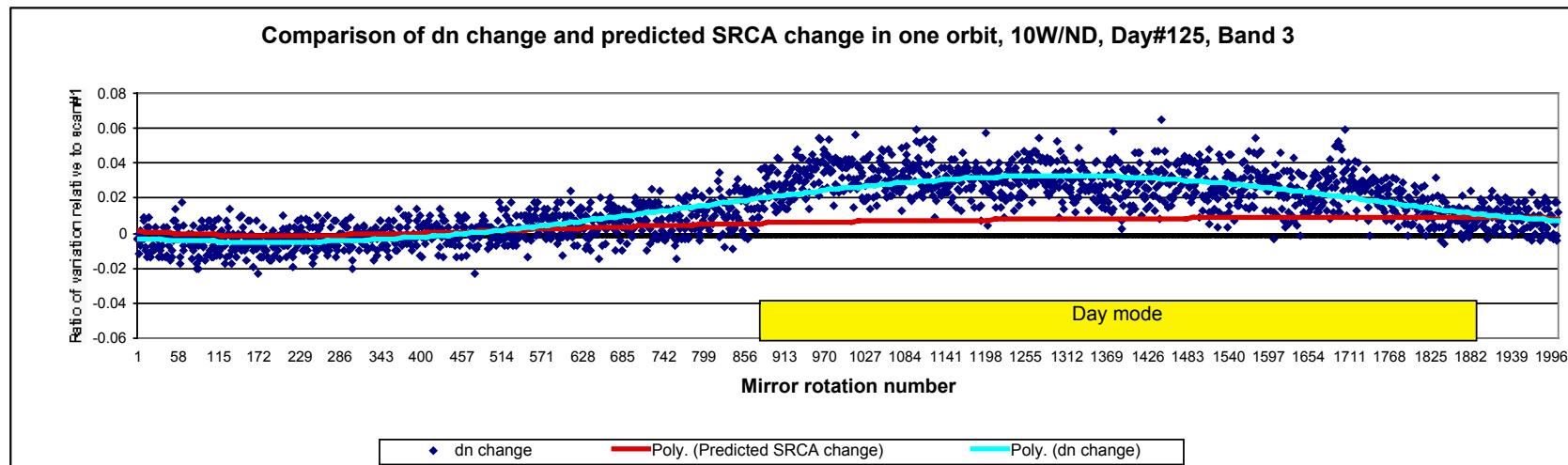
# Preliminary

## dn'/SRCA change over one orbit (10W/ND lamp) (1)



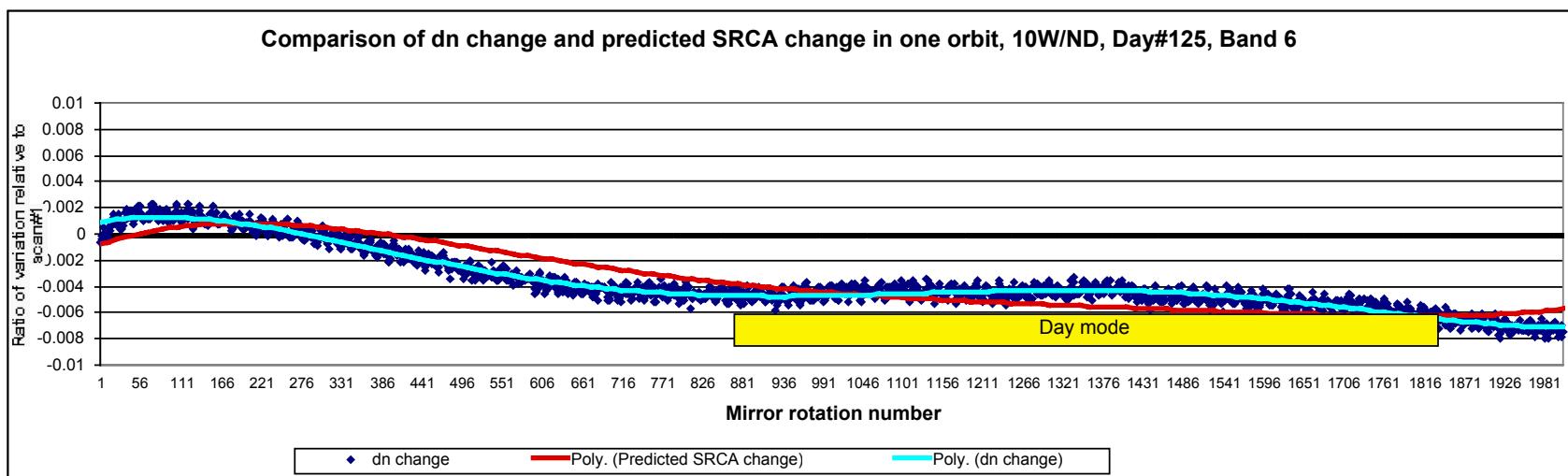
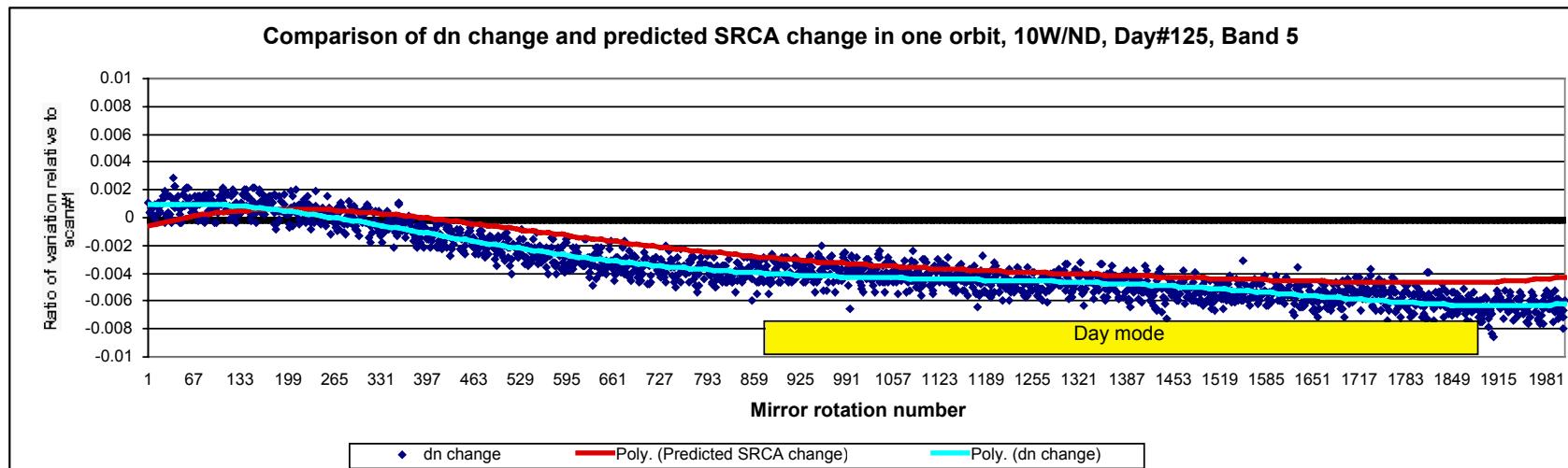
# Preliminary

## dn'/SRCA change over one orbit (10W/ND lamp) (2)



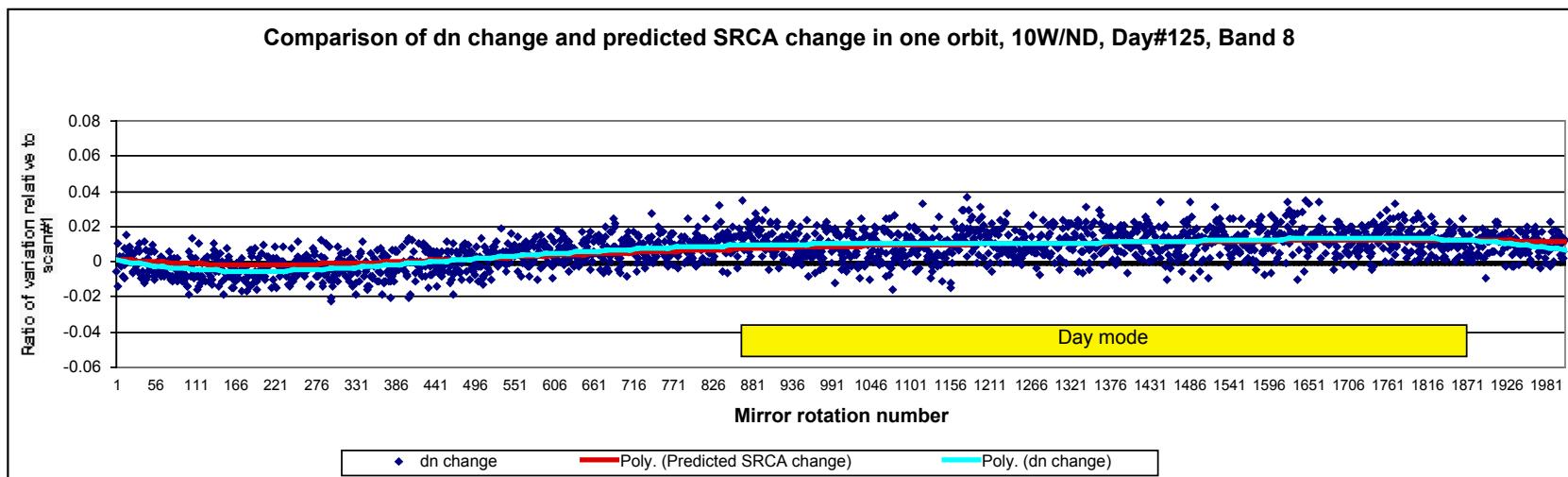
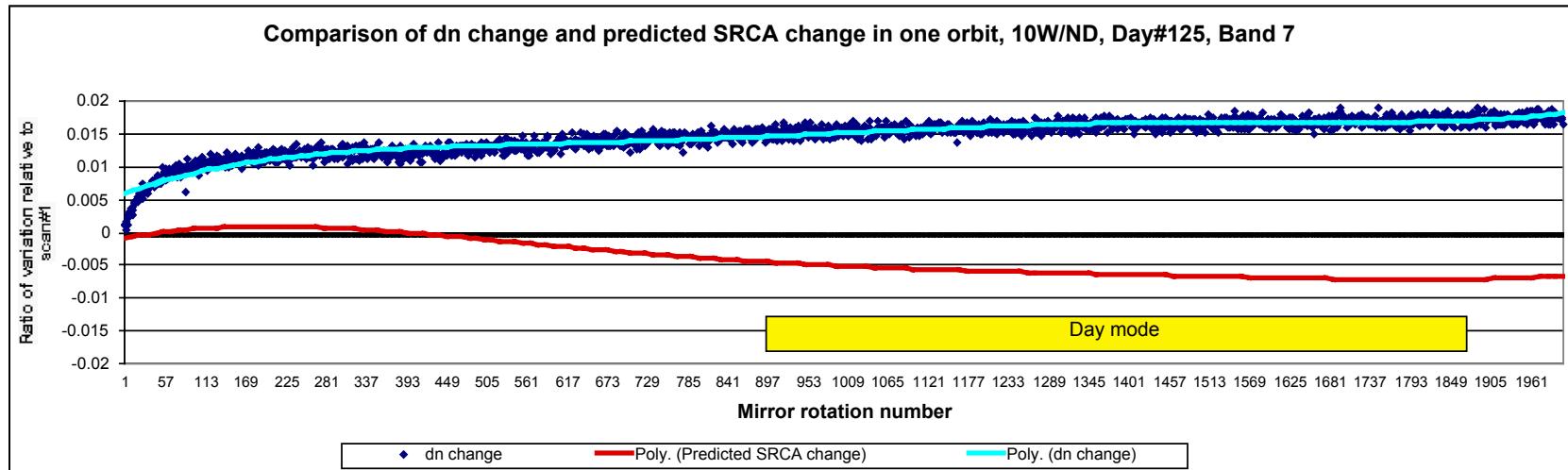
# Preliminary

## dn'/SRCA change over one orbit (10W/ND lamp) (3)



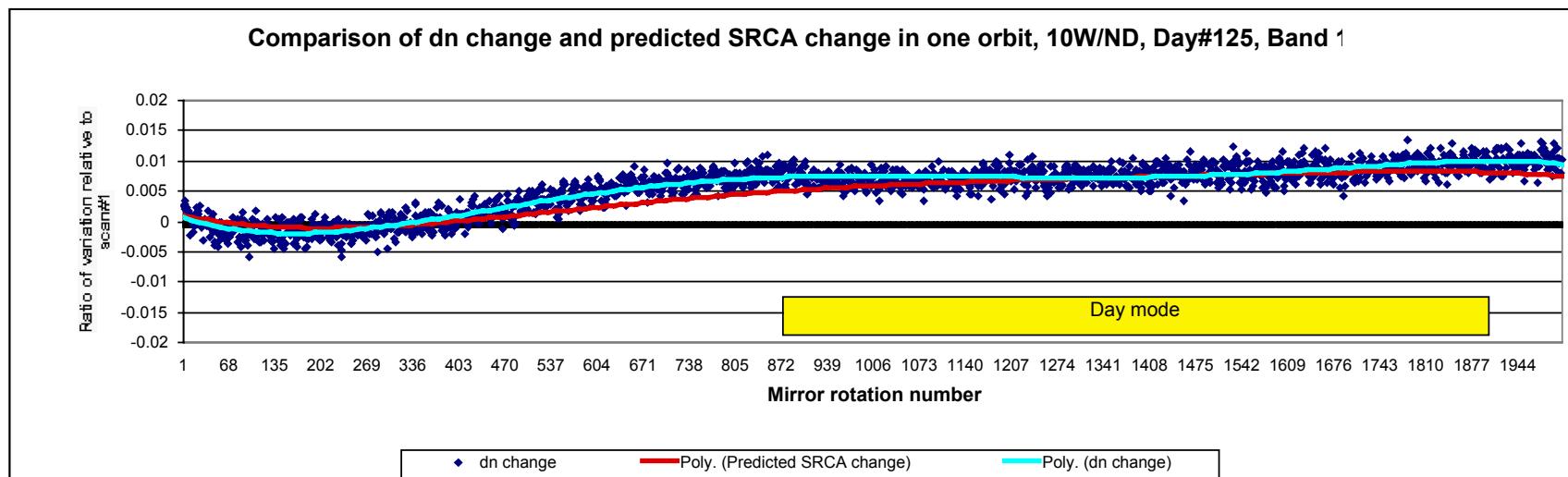
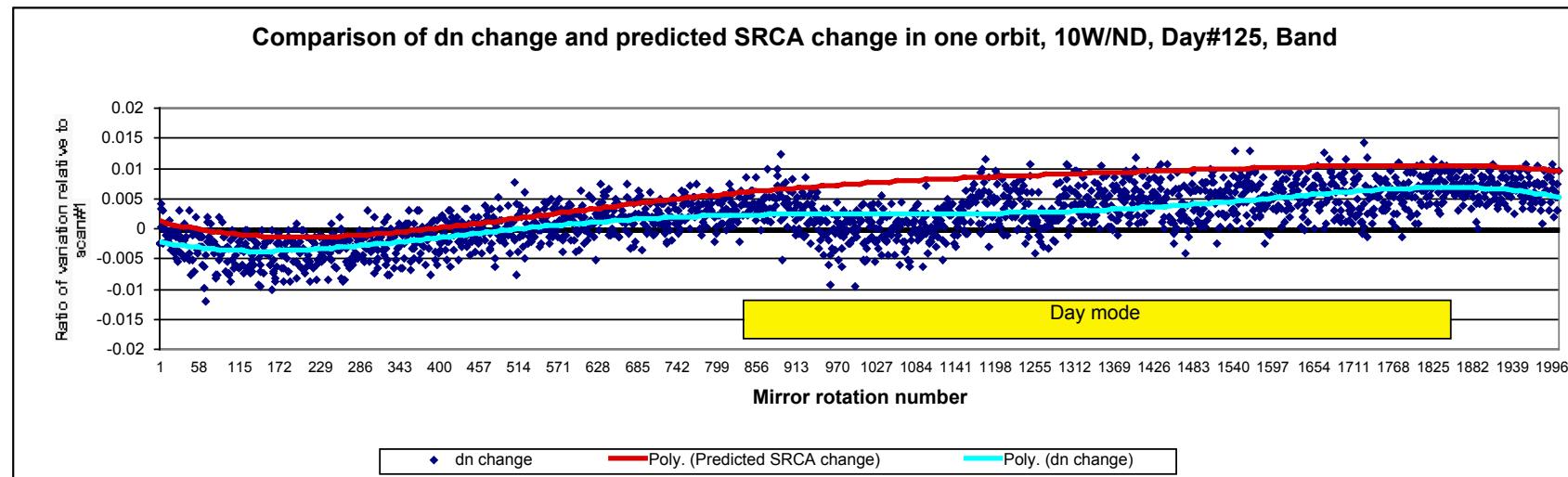
# Preliminary

## dn'/SRCA change over one orbit (10W/ND lamp) (4)



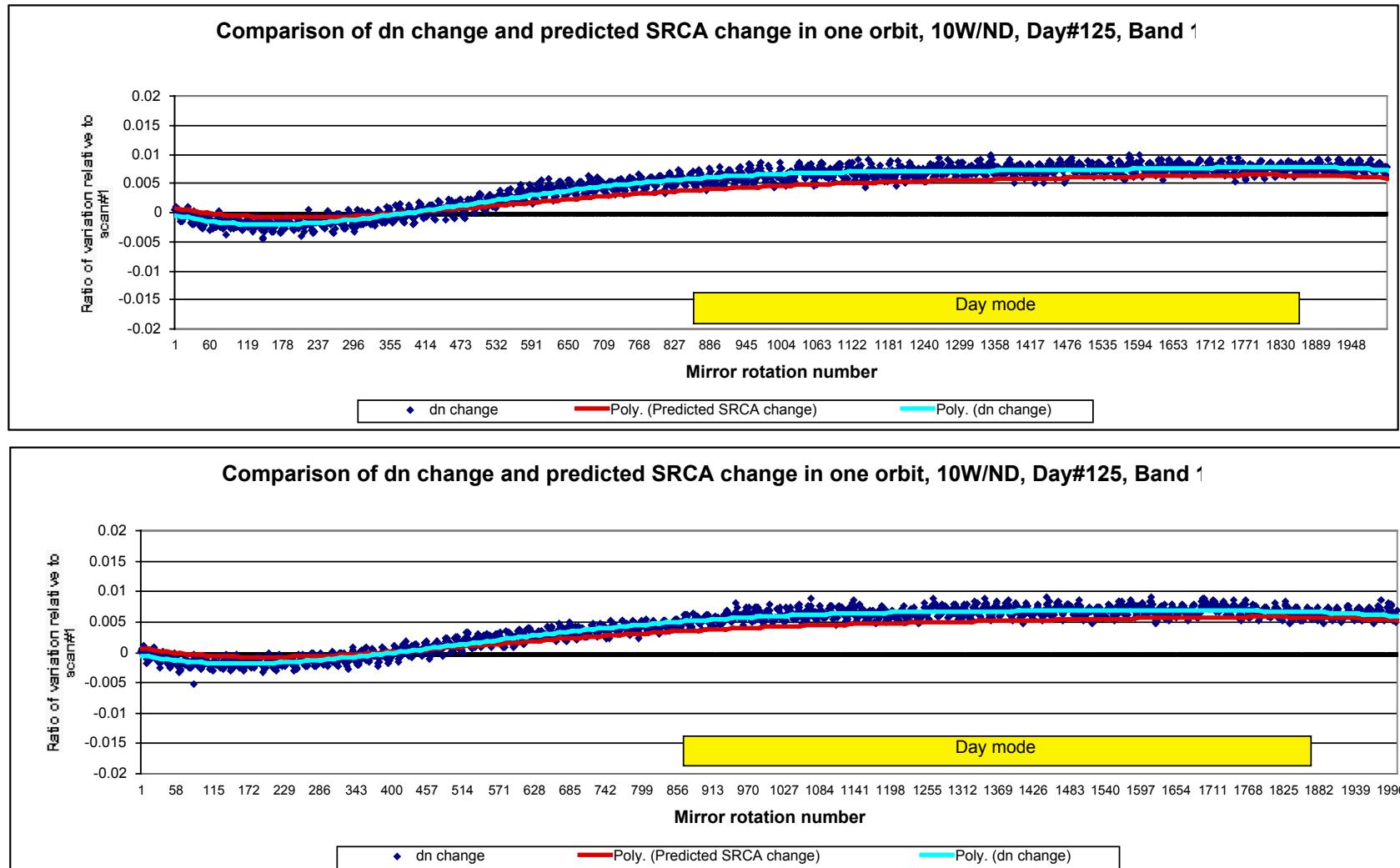
# Preliminary

## dn'/SRCA change over one orbit (10W/ND lamp) (5)



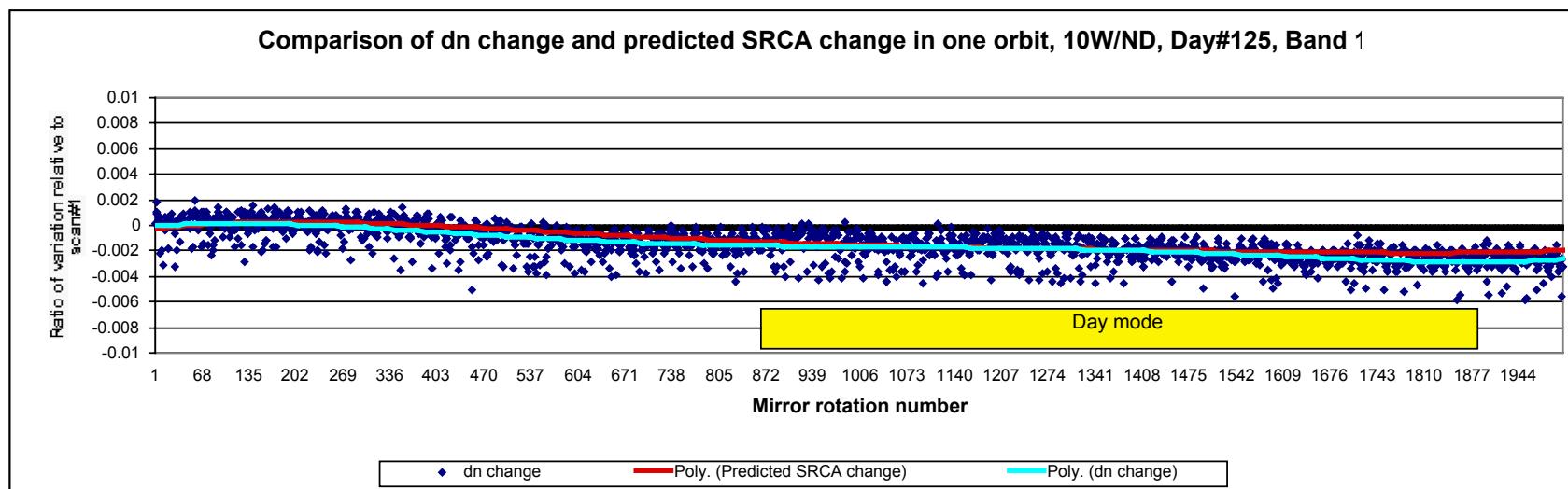
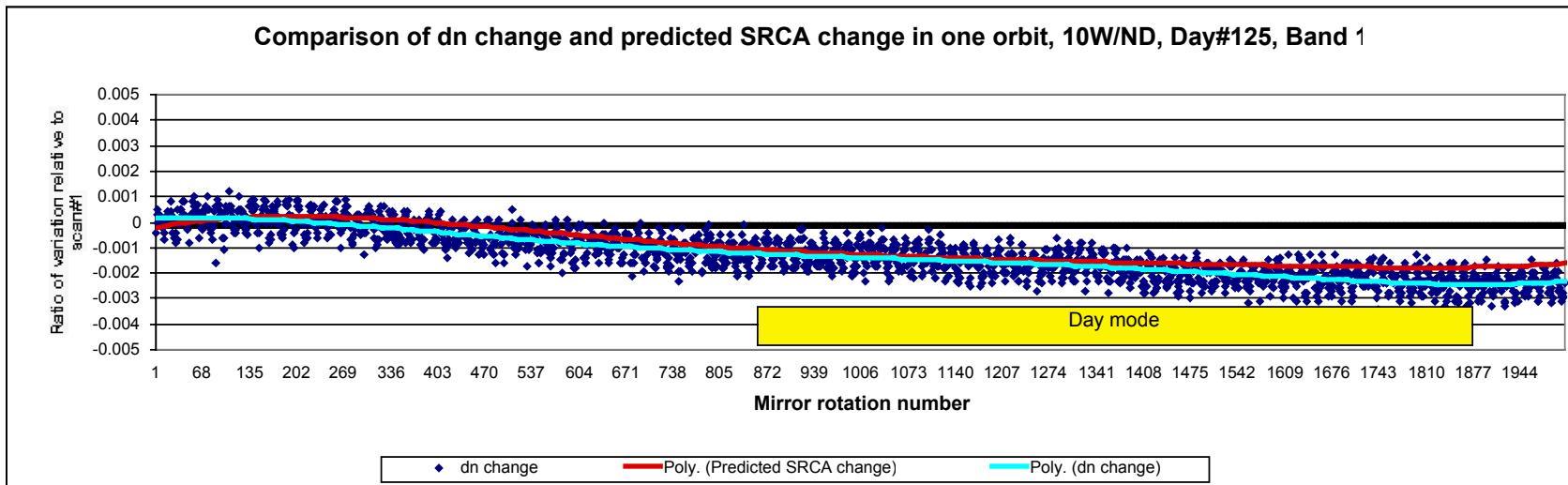
# Preliminary

## dn'/SRCA change over one orbit (10W/ND lamp) (6)



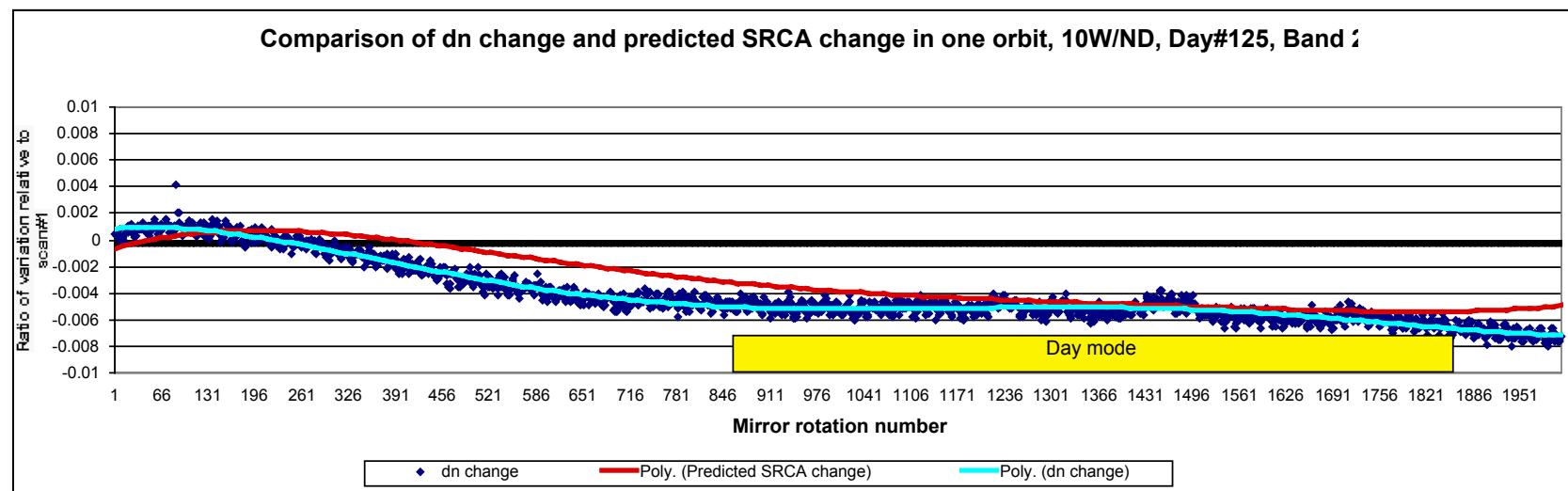
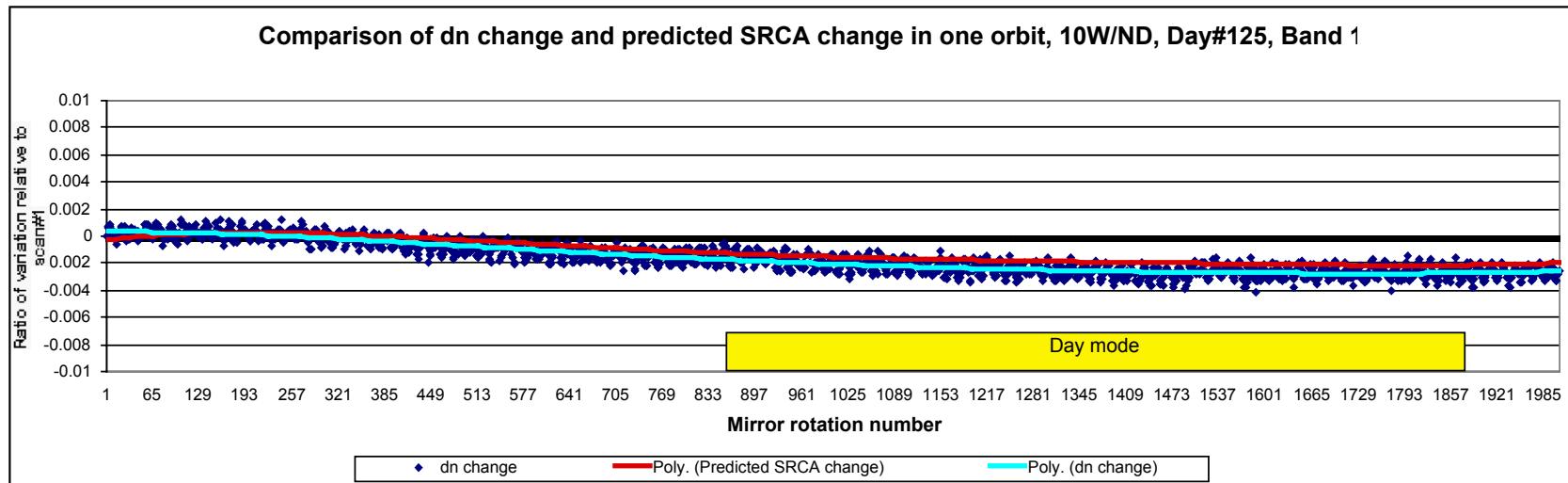
# Preliminary

## dn'/SRCA change over one orbit (10W/ND lamp) (7)



# Preliminary

## dn'/SRCA change over one orbit (10W/ND lamp) (8)



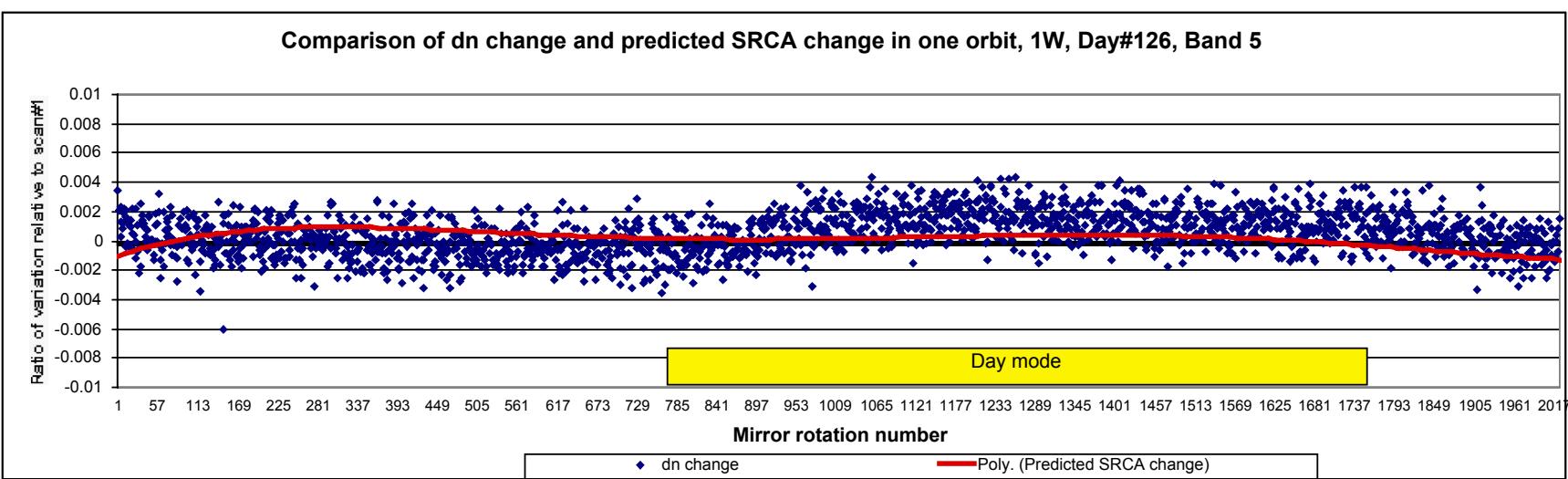
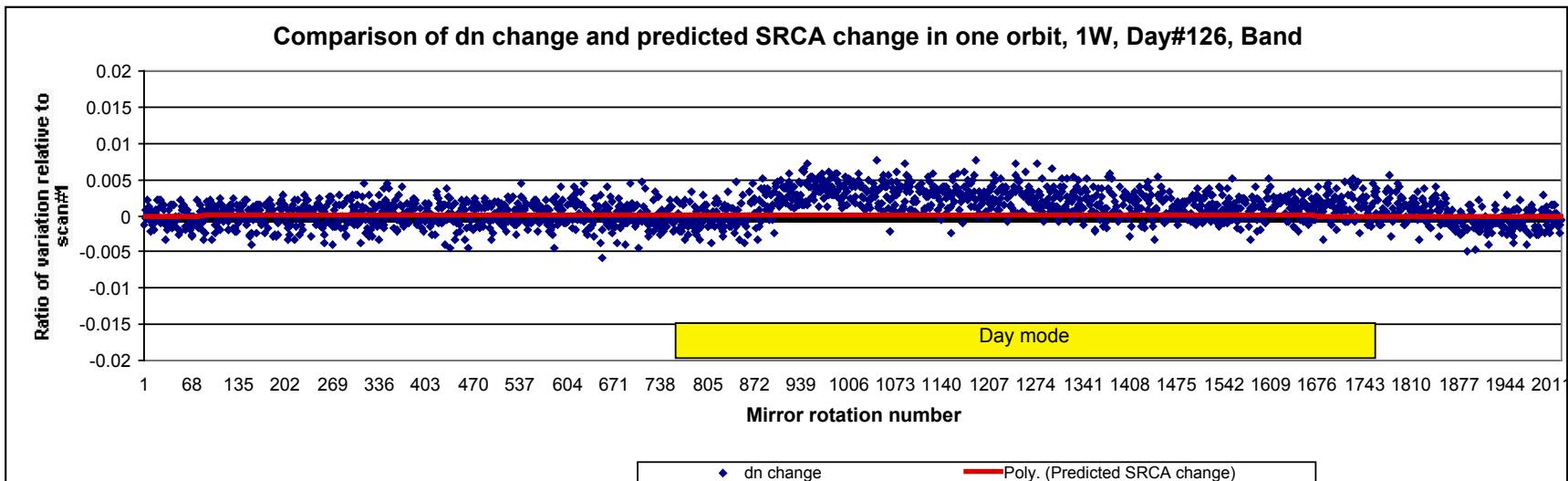
## Summary of detector dn' change under 1W lamp

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- ◆ The following the charts are for bands 2, 5 - 7, 12 - 19, 26, 37(13hi), and 38(14hi)
- ◆ The fifth order polynomial is not illustrated for dn' because the sine-shape variation may lead to the trending curve meaningless at the end of scans.
- ◆ The random variation of dn' should include the variation of the SRCA because the SRCA 1W lamp feedback control is at 1% precision level.
- ◆ dn' change is detectable for bands 2, 5, 6, 15, 16, 26, and 38; and is very limited for bands 7, 12 - 14, 17 - 18, and 37. The detectable change may be attributable to the change between day mode and night mode because the dn' seems to have a sine-shape with a period of 50 minutes (at 760 to 1760 mirror rotations).
- ◆ Under the SRCA 1W illumination, the DN change is limited. Except for bands 2 and 12 (low DNs), the dn' variation is at a level of  $\pm 0.1\%$  over one orbit.

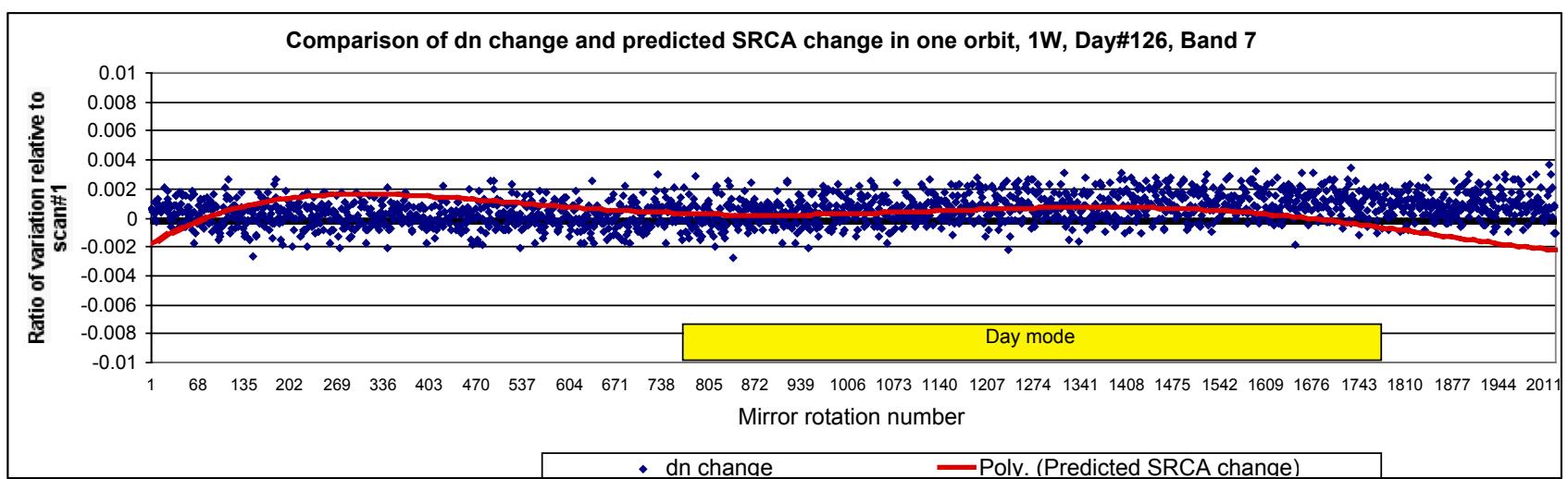
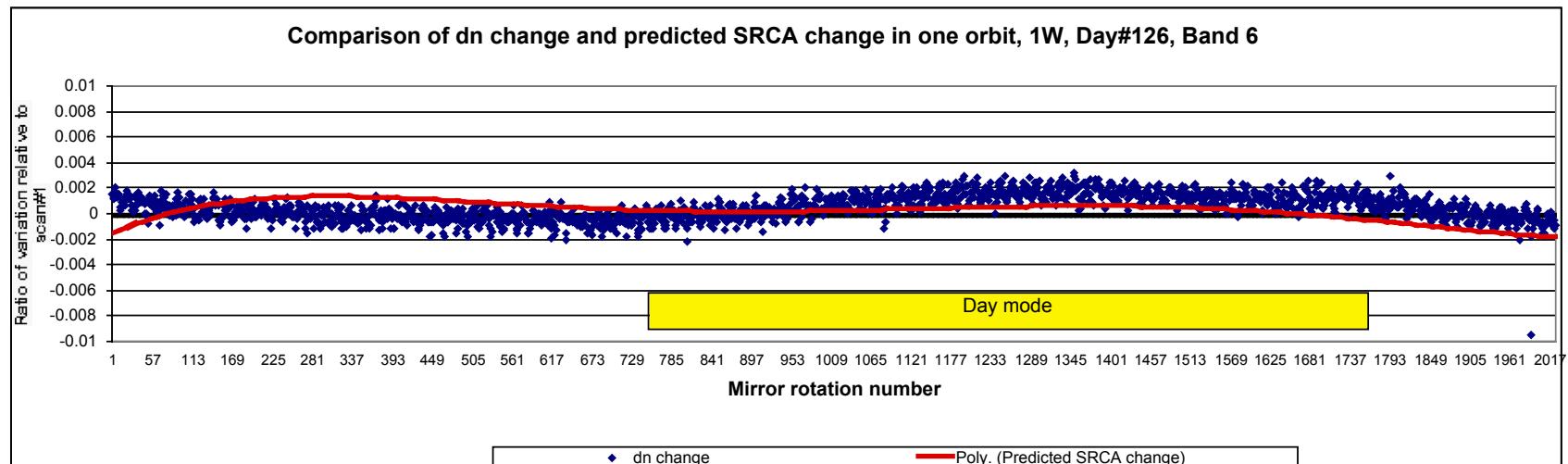
# Preliminary

## dn'/SRCA change over one orbit (1W lamp) (1)



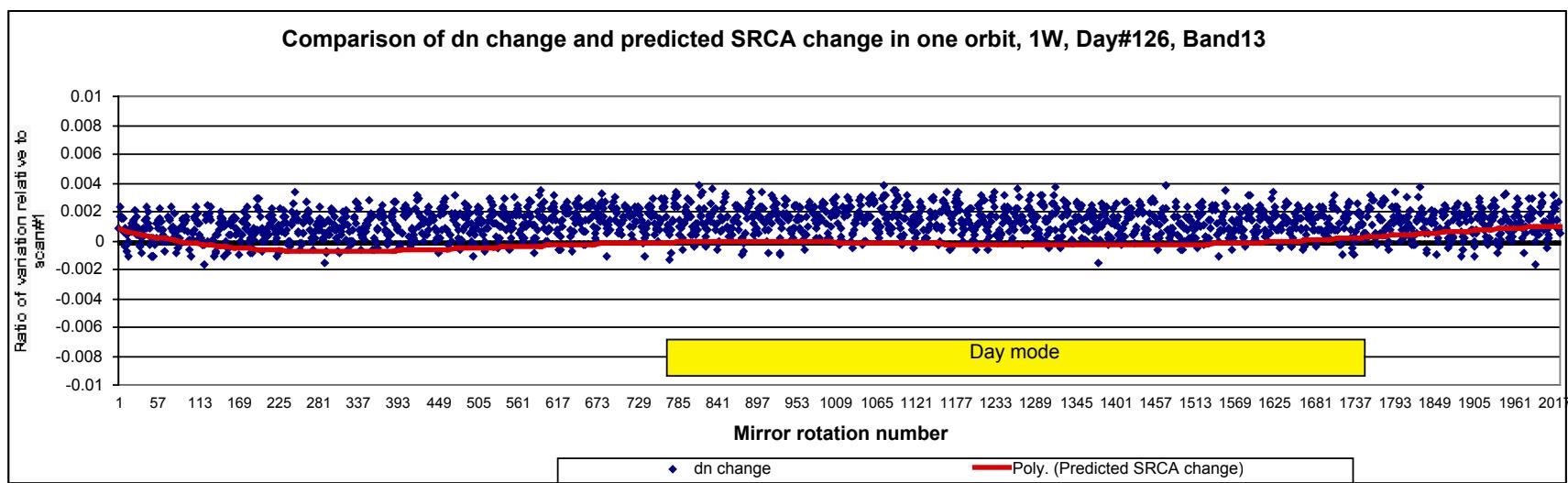
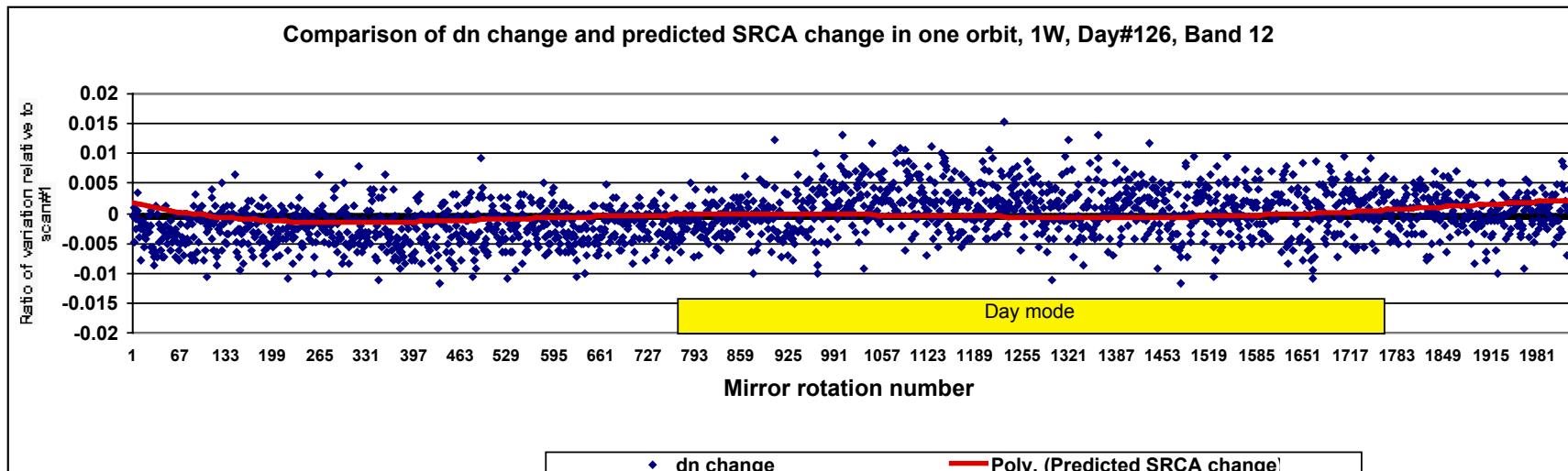
# Preliminary

## dn'/SRCA change over one orbit (1W lamp) (2)



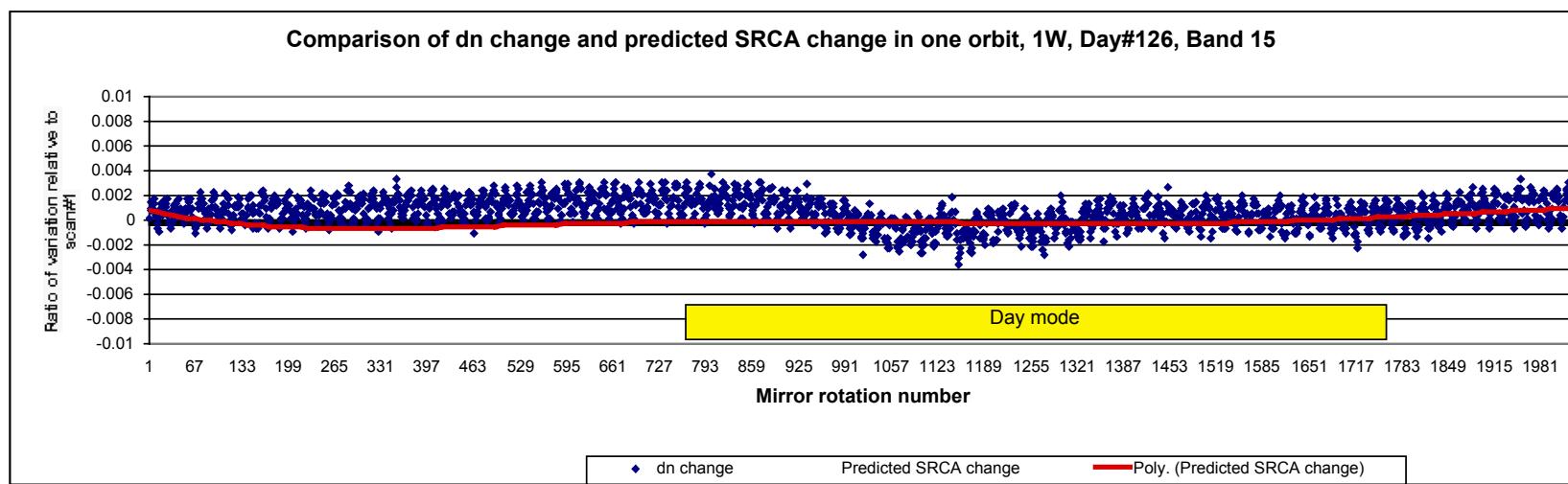
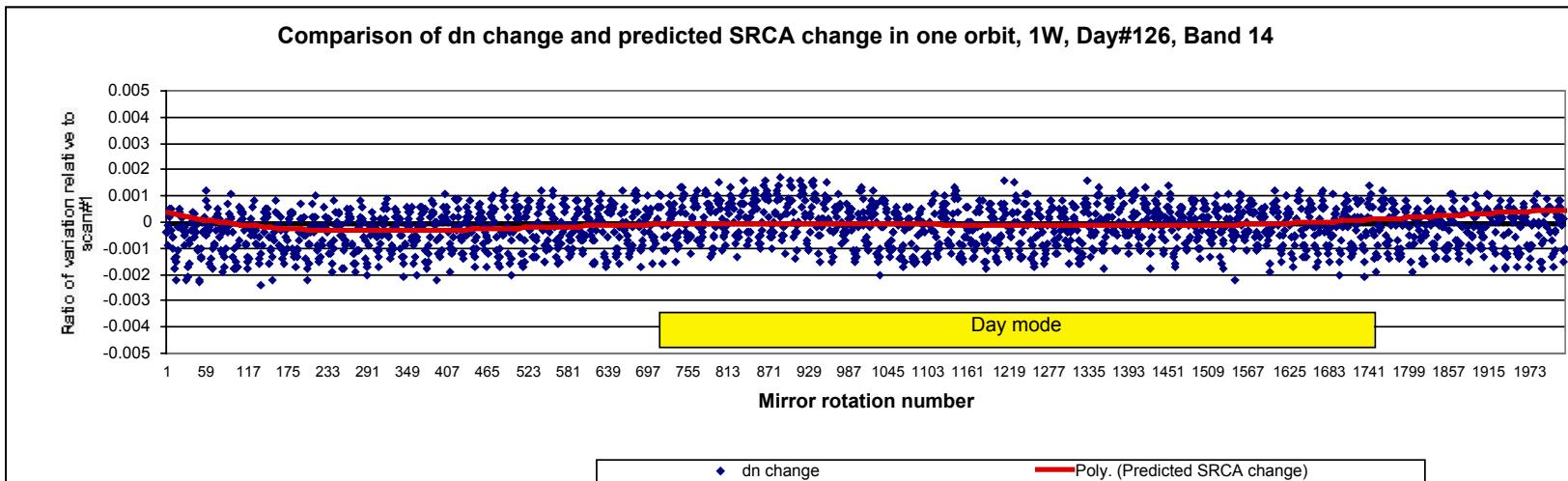
# Preliminary

## dn'/SRCA change over one orbit (1W lamp) (3)



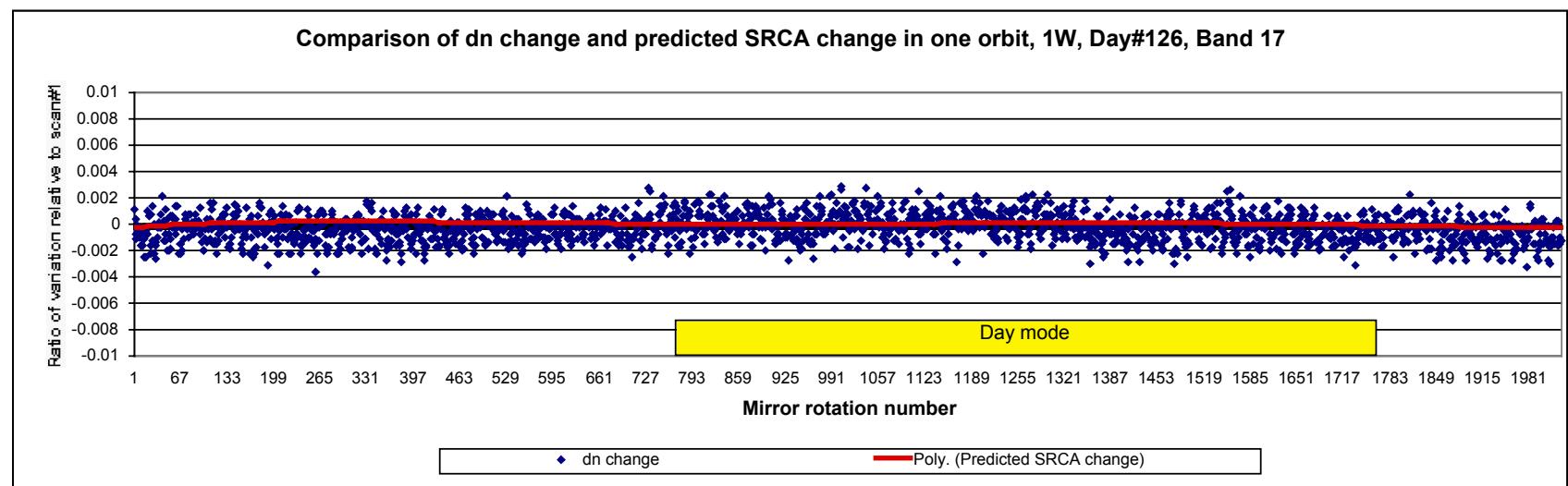
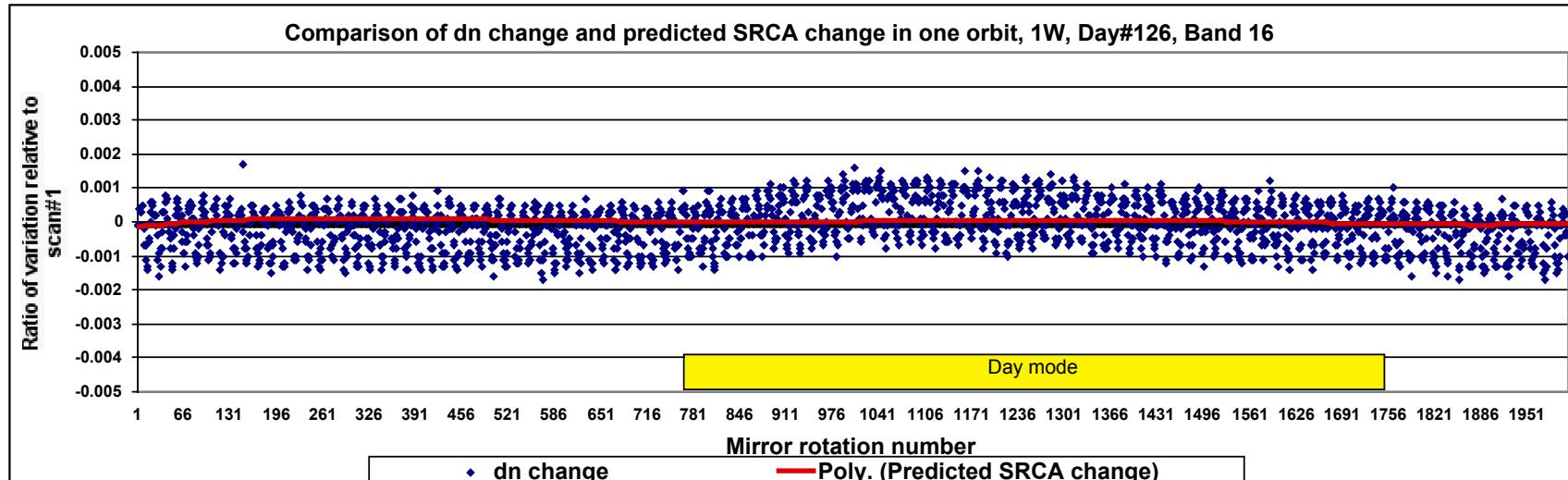
# Preliminary

## dn'/SRCA change over one orbit (1W lamp) (4)



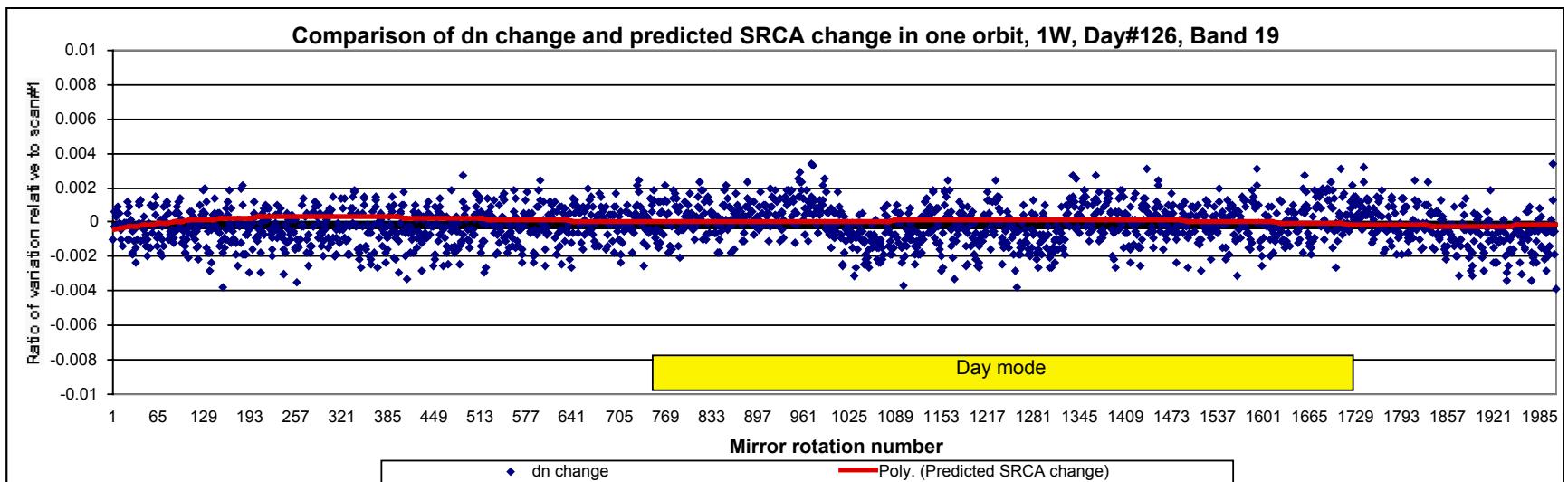
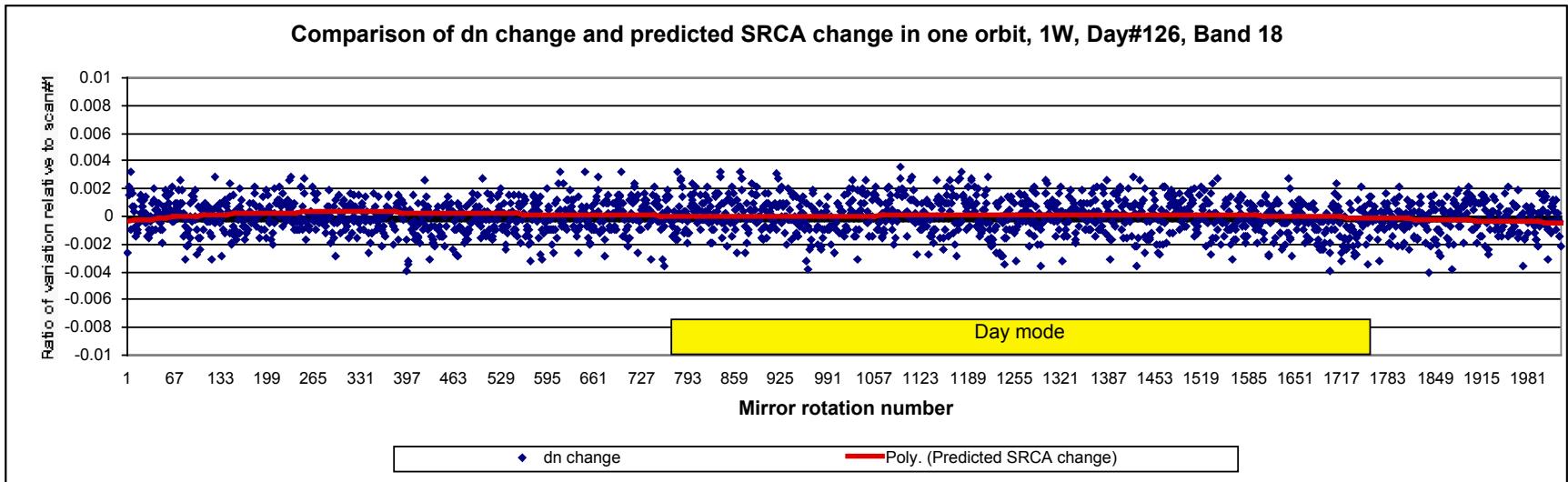
# Preliminary

## dn'/SRCA change over one orbit (1W lamp) (5)



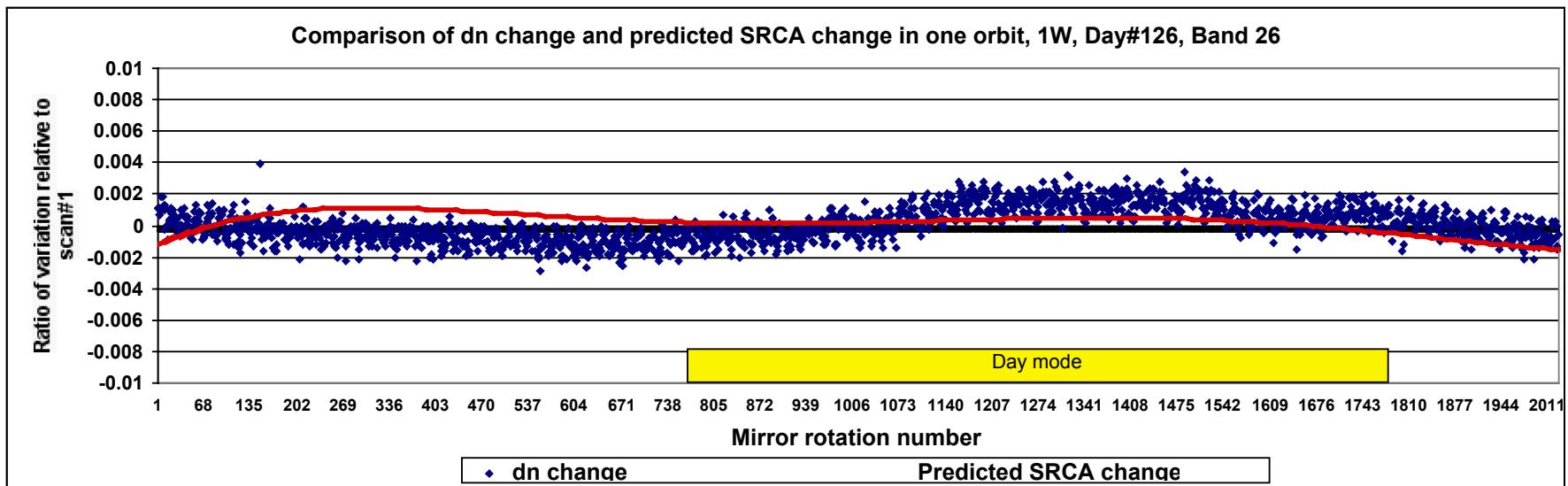
# Preliminary

## dn'/SRCA change over one orbit (1W lamp) (6)



Preliminary

## dn'/SRCA change over one orbit (1W lamp) (7)



# Preliminary

## dn'/SRCA change over one orbit (1W lamp) (8)

